Challenges That Might Benefit From Standards Development:

Interface Software

NIH Workshop on Standards and Modularity of Brain-Computer Interfaces and Neuroprostheses

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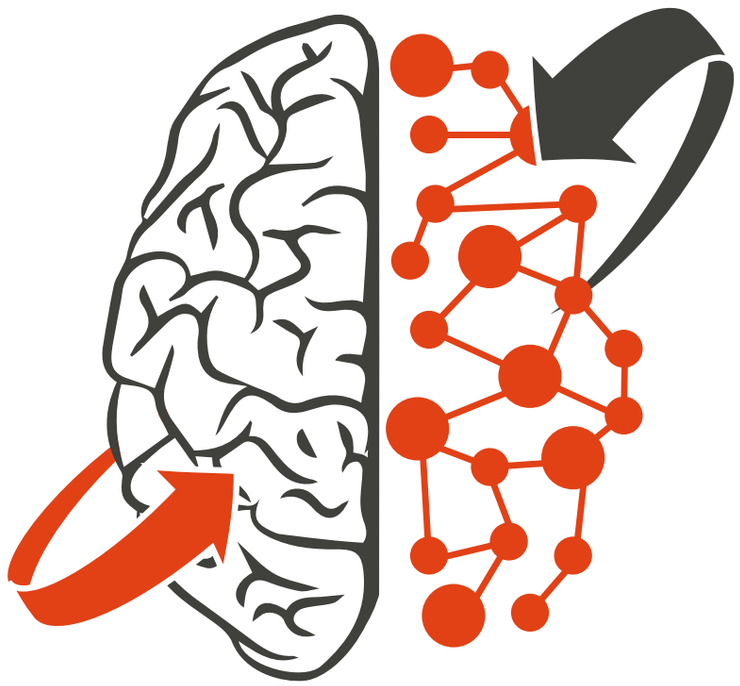

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Prospect of Software Standardization

Reducing the time, complexity, risk, and cost of BCI system development

Elements of Software Standardization

- Data format
- Interfaces between or within sensors, software, and effector

Principal Challenges of Software Standardization

Fundamental tradeoff between standardization/ modularization and system performance

Huge functional/technical space to cover

Standardization of hardware and software across the whole BCI space is *unrealistic*

Specific Challenges of Software Standardization

Impossible to engineer general system that is guaranteed to have sufficient tech specs

Technical or physiological dependencies between sensors, software, and effector

Insufficient recognition of the substantial difficulty of BCI software development

“Not invented here” syndrome

Specific Challenges of Software Standardization II

Commercial:
Benefit of vertical integration exceeds benefit of horizontal integration

Academic:
What are the *perceived* incentives to conforming to standards?

Practical Suggestions

Commercial:
Not sure

Academic:
Add funding incentives to using standard software

BCI2000:
General-Purpose BCI Software

What it is:
A widely adopted general-purpose software that integrates data acquisition, real-time processing, and stimulus presentation/feedback

Purpose:
Support large-scale research programs in BCI and related fields

BCI2000:
General-Purpose BCI Software

- Acquired by more than 4000 users world-wide
- Used in hundreds of peer-reviewed papers
- Many papers set new directions in BCI research
- BCI2000 is the basis for the first large-scale clinical BCI trial
- Its use extensively featured in scientific and popular media (e.g., NBC, CBS, CNN, Discovery, NPR)

BCI2000:
General-Purpose BCI Software

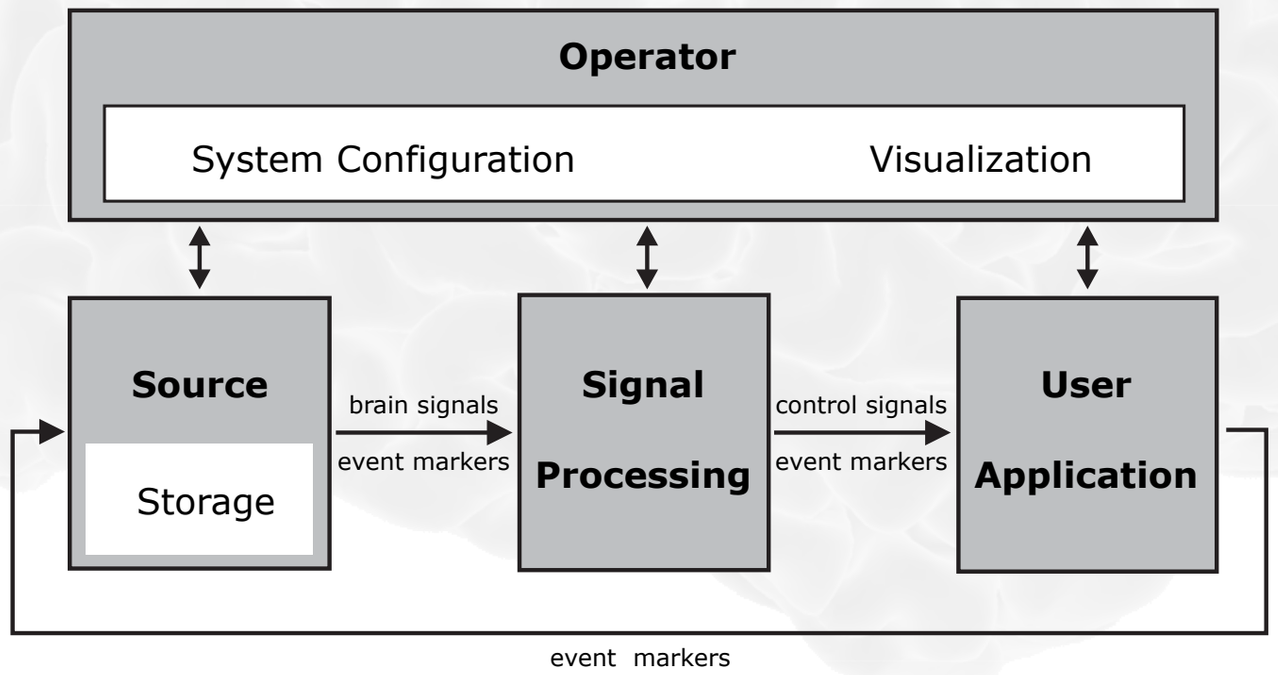
- Schalk et al., *IEEE Trans Biomed Eng*, 2004
- Mellinger and Schalk, *MIT Press*, 2007
- Mellinger and Schalk, *Springer*, 2008
- Schalk, G., *Proc IEEE EMBS*, 2009
- Schalk, G. and Mellinger, J.:
  Brain-Computer Interfacing Using BCI2000. *Springer*, 2010.
- Wilson, J.A., and Schalk, G. *Springer*, 2010
- Melllinger, J., and Schalk, G. *Springer*, 2011

http://www.bci2000.org

System Model

BCI2000 V1.0

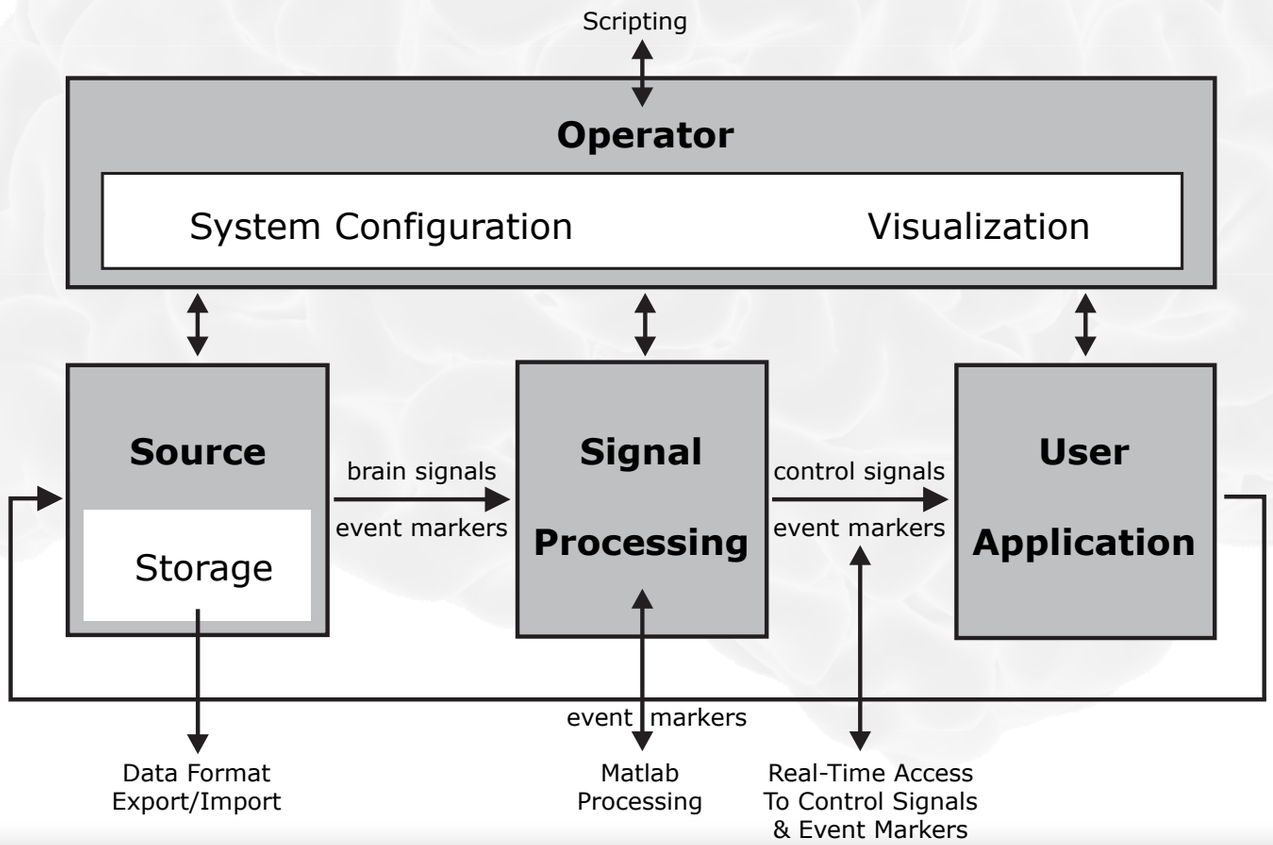
2000-2007



System Model

BCI2000 V2.0

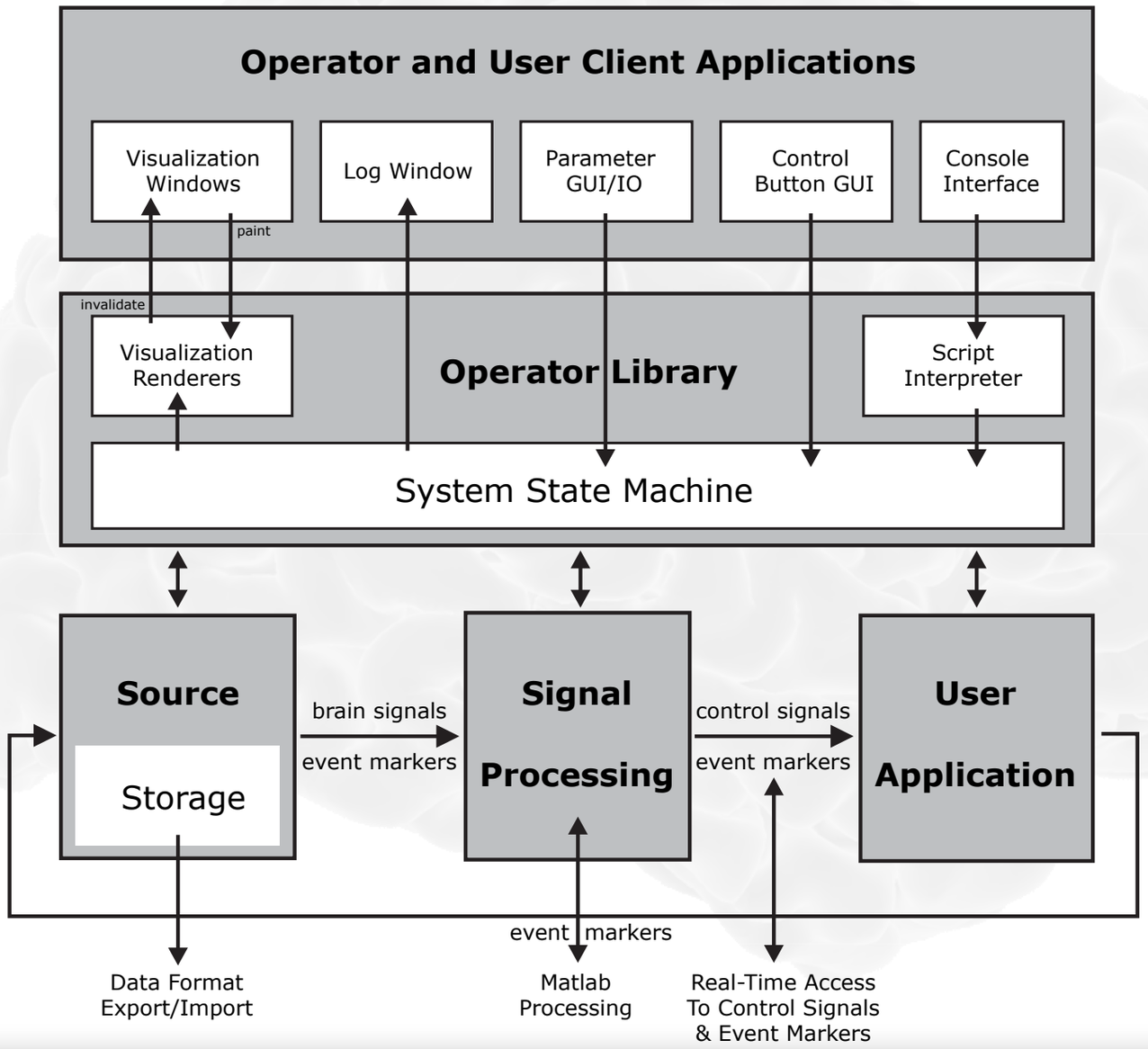
2008



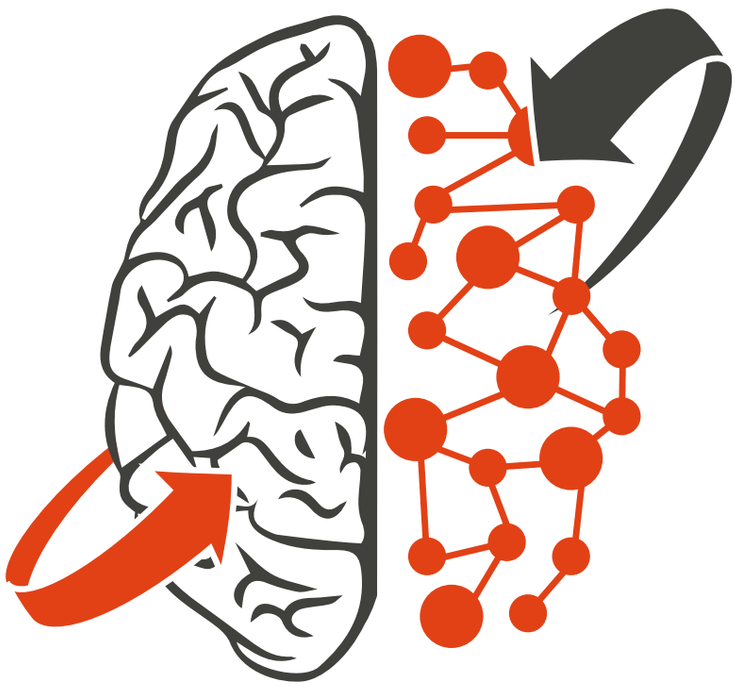
System Model

BCI2000 V3.0

2011



Credits



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US Army: W911NF-08-1-0216, W911NF-12-1-0158, W911NF-12-1-0109, W911NF-13-1-0479, W911NF-14-1-04
NIH: R01-EB000856, R01-EB006356, P41-EB018783; **Fondazione Neurone**